Alternatives Analysis Technical Report
Appendix E: AIR QUALITY TECHNICAL MEMORANDUM

Red Line/Blue Line Connector Project

Boston,
Massachusetts

Massachusetts Department of Transportation
Boston, Massachusetts

Moving Massachusetts Forward.
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Massachusetts Department of Transportation

Red Line
Blue Line
CONNECTOR

March 2010

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Introduction

1.1 Air Quality Background

This air quality study includes a local and regional air quality analysis of the Red Line/Blue Line Connector Project that demonstrates compliance with the State Implementation Plan (SIP) and Transportation Conformity. The local or microscale analysis evaluated carbon monoxide (CO) and particulate matter (PM). The regional or mesoscale analysis evaluated ozone precursors (volatile organic compounds (VOCs), oxides of nitrogen (NO_X), CO, and PM the greenhouse gas carbon dioxide (CO_2).

The Secretary of the Executive Office of Energy and Environmental Affairs (EEA) issued a Certificate on the EENF on November 15, 2007.[1] Included in the certificate are a number of requirements defining the scope of the Draft Environmental Impact Report (DEIR). The following outlines the requirements for the evaluation of air quality impacts.

- The DIER should describe the air quality benefits associated with this project and describe its consistency with the State Implementation Plan (SIP) and Massachusetts's Department of Environmental Protection (DEP's) Transit Regulations.
- The DEIR should clarify if air quality permits are required from State or Federal agencies in association with the construction or operation of the project.
- The DEIR should include modeling data and assumptions to support claims in the EENF that the project will result in a reduction in emissions for CO, NO_X, and VOC.
- The proponent should address potential air quality impacts during the construction phase and propose sufficient mitigation to offset increases in localized construction period air quality.

[1] Massachusetts Executive Office of Energy and Environmental Affairs. *Certificate of the Secretary of Energy and Environmental Affairs on the Expanded Environmental Notification Form*. On the Red Line/Blue Line Connector (EEA # 14101), November 15, 2007.

- The DEIR should include a mesoscale and microscale air quality analysis. The analyses should analyze the following emissions: VOC, NO_X, greenhouse gases, CO, particulate matter, and air toxics. These analyses should demonstrate that the project will result in measurable local and regional air quality improvements and total emission reductions.
- EOT and the MBTA should consult with MassDEP regarding the development of the study protocols before initiating the study and submitting the DEIR.

The following chapters discuss the air quality evaluation methodology and potential air quality impacts by elements of the Red Line/Blue Line Connector Project. Chapter 2 identifies the air quality analysis methodology including the standards and references. Chapter 3 describes the air quality results for the project elements. Chapter 4 reviews the potential temporary construction impacts and related mitigation.

An air quality modeling protocol, dated November 24, 2009, was submitted to the Environmental Protection Agency (EPA) and the Massachusetts Department of Environmental Protection (DEP). The protocol discusses the modeling procedures and assumptions used in the National Environmental Policy Act (NEPA) project level air quality evaluation. The Federal Transit Administration (FTA) and the Federal Highway Administration (FHWA) in cooperation with the EPA have established procedures for Transportation Conformity requirements of the Clean Air Act Amendments to address the NEPA planning level air quality evaluation. The Transportation Conformity requirements are intended to integrate transportation and air quality planning in areas that are designated by the EPA as not meeting the National Ambient Air Quality Standards (NAAQS). Guidance from both the EPA and DEP define the air quality modeling and review criteria for analyses prepared pursuant to the 1990 Clean Air Act Amendments (CAAA). The CAAA require that a proposed project not:

- Cause any new violation of the NAAQS;
- Increase the frequency or severity of any existing violations; or
- Delay attainment of any NAAQS.

The CAAA resulted in states being divided into attainment and non-attainment areas with classifications based upon the severity of their air quality problem. A non-attainment area is an area that has had measured pollutant levels that exceed NAAQS and that has not been designated as attainment. The CAAA established emission reduction requirements that vary by an area's classification.

1.1.1 Pollutants of Concern and Attainment Status

Air pollution is of concern because of its demonstrated effects on human health. Of special concern are the respiratory effects of the pollutants and their potential toxic effects, as described below. This section also describes the attainment status of the study area for each pollutant.

Carbon Monoxide

Carbon monoxide is a colorless and odorless gas that is a product of incomplete combustion. Carbon monoxide is absorbed by the lungs and reacts with hemoglobin to reduce the oxygen carrying capacity of the blood. At low concentrations, CO has been shown to aggravate the symptoms of cardiovascular disease. It can cause headaches and nausea and, at sustained high concentration levels, can lead to coma and death.

The proposed Project is located in the City of Boston (Suffolk County) which is in attainment. Only proposed projects that are located in CO non-attainment or Maintenance attainment areas are required to evaluate their impact on CO concentrations and the NAAQS. However, because the Project is following the Massachusetts Environmental Policy Act (MEPA) process, a CO analysis was conducted.

Particulate Matter

Particulate matter is made up of small solid particles and liquid droplets. PM_{10} refers to particulate matter with a nominal aerodynamic diameter of 10 micrometers or less, and $PM_{2.5}$ refers to particulate matter with an aerodynamic diameter of 2.5 micrometers or less. Particulates can enter the body through the respiratory system. Particulates over 10 micrometers in size are generally captured in the nose and throat and are readily expelled from the body. Particles smaller than 10 micrometers, and especially particles smaller than 2.5 micrometers, can reach the air ducts (bronchi) and the air sacs (alveoli) in the lungs. Particulates are associated with increased incidence of respiratory diseases, cardiopulmonary disease, and cancer.

The proposed Project is located in the City of Boston which is in attainment for PM. Under the Massachusetts Environmental Policy Act (MEPA) process, a PM analysis is typically not required unless the Project is in a non-attainment area or an analysis is specifically requested by MassDEP or EEA.

Ozone

Ozone is a strong oxidizer and an irritant that affects the lung tissues and respiratory functions. Exposure to ozone can impair the ability to perform physical exercise, can result in symptoms such as tightness in the chest, coughing, and wheezing, and can ultimately result in asthma, bronchitis, and emphysema.

Massachusetts has been determined to be a non-attainment area, statewide, for ozone. The State has been divided into two non-attainment areas, Eastern and Western Massachusetts. On June 15, 2005, the EPA revoked the 1-hour ozone standard for most areas in the country. This action means that the 1-hour ozone non-attainment area classified as “Serious,” is no longer applicable for Eastern Massachusetts. Only the 8-hour ozone NAAQS applies. The Project is located in the Eastern Massachusetts 8-hour ozone non-attainment area which has been classified as “Moderate.”

Volatile Organic Compounds

VOCs are a general class of compounds containing hydrogen and carbon and are a precursor to the formation of the pollutant ozone. While concentrations of VOCs in the atmosphere are not generally measured, ground-level ozone is measured and used to assess potential health effects. Emissions of VOCs and NO_X react in the presence of heat and sunlight to form ozone in the atmosphere. Accordingly, ozone is regulated as a regional pollutant and is not assessed on a project-specific basis.

Nitrogen Oxides

When combustion temperatures are extremely high, as in automobile engines, atmospheric nitrogen gas may combine with oxygen gas to form various oxides of nitrogen. Of these, nitric oxide (NO) and NO_2 are the most significant air pollutants. This group of pollutants is generally referred to as nitrogen oxides or NO_X. Nitric oxide is relatively harmless to humans but quickly converts to NO_2. Nitrogen dioxide has been found to be a lung irritant and can lead to respiratory illnesses. Nitrogen oxides, along with VOCs, are also precursors to ozone formation.

Carbon Dioxide

Greenhouse gases (GHG) are essential to maintaining the temperature of the Earth, without them the planet would be so cold as to be uninhabitable. While there are other GHGs, CO_2 is the predominant contributor to global warming from transportation sources, and emissions can be calculated for CO_2 with readily accessible data.

The EEA issued a policy and protocol for evaluating GHG emissions from proposed projects with particular emphasis on carbon dioxide (CO_2) emissions. This policy requires that EIR projects quantify greenhouse gas emissions generated by the project and identify measures to reduce or minimize these impacts.

1.1.2 Air Quality Standards

The EPA has set the NAAQS for CO to protect the public health. Table 1-1 outlines the NAAQS for all of the pollutants. The predominant source of pollution anticipated from the proposed Project is emissions from project-related motor vehicle traffic. CO is directly emitted by motor vehicles. CO concentrations can be estimated by computer modeling, which can then be compared to the NAAQS.

Table 1-1 National Ambient Air Quality Standards

	Primary Standards		Secondary Standards	
Pollutant	Level	Averaging Time	Level	Averaging
Carbon Monoxide	9 ppm (10 mg/m^3) 35 ppm (40 mg/m^3)	8-hour[1] 1-hour[1]	None None	
Lead	0.15 ug/m^3	Quarterly Average	Same as Primary	
Nitrogen Dioxide	0.053 ppm (100 ug/m^3)	Annual (Arithmetic Mean)	Same as Primary	
Particulate Matter (PM_{10})	150 ug/m^3	24-hour[2]	Same as Primary	
Particulate Matter ($PM_{2.5}$)	15 ug/m^3 35 ug/m^3	Annual (Arithmetic Mean) [3] 24-hour[4]	Same as Primary Same as Primary	
Ozone	0.075 ppm (2008 std) 0.08 ppm (1997 std) 0.12 ppm	8-hour[5] 8-hour[6] 1-hour (applied to limited areas) [7]	Same as Primary Same as Primary	
Sulfur Dioxide	0.03 ppm 0.14 ppm	Annual 24-hour[1]	0.5 ppm	3-hour

1 Not to be exceeded more than once per year.
2 Not to be exceeded more than once per year on average over 3 years.
3 To attain this standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 15.0µg/m3.
4 To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m3 (effective December 17, 2006).
5 To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm. (Effective 60 days after publication in the Federal Register)
6 (a) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.
(b) The 1997 standard—and the implementation rules for that standard—will remain in place for implementation purposes as EPA undertakes rulemaking to address the transition from the 1997 ozone standard to the 2008 ozone standard.
7 (a) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is < 1.
(b) As of June 15, 2005 EPA revoked the 1-hour ozone standard in all areas except the 8-hour ozone nonattainment Early Action Compact (EAC) Areas.

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2

Methodology

2.1 Mobile Source Air Quality Modeling Methodology

The EPA and DEP have established guidelines that define the modeling and review criteria for local and regional air quality analyses prepared pursuant to the MEPA process. These guidelines require that the proposed project determine the change in project related vehicle emissions. If the VOC and emissions from the Build Alternatives are greater than the No-Build Alternative, then the proposed project should include all reasonable and feasible emission reduction mitigation measures. Massachusetts has incorporated this criterion into the State Implementation Plan (SIP).

The EPA and DEP guidelines require that the air quality study utilize traffic and emissions data for existing and future (No-Build and Build) conditions. The traffic and emissions data are incorporated into the EPA air quality models and modeling procedures to generate emissions estimates that demonstrate whether or not the proposed project will have air quality impacts.

The air quality study for the project evaluated several conditions, including the 2009 existing conditions, the 2018 and 2030 No-Build Alternative, and two Build Alternatives in both 2018 and 2030. The two Build Alternatives include Alternative 1 which is the Red Line/Blue Line Connector without Bowdoin Station and Alternative 2 is the Red Line/Blue Line Connector with Bowdoin Station. The Alternatives are described in more detail in the *Alternatives Analysis Technical Report*. The study area is presented in Figure 2-1.

The No-Build Alternative (2018 and 2030) included regional background traffic growth and planned roadway improvements. The Build Alternatives include the anticipated future changes in travel demand due to each alternative. The year 2018 was analyzed as it represents the estimated date of completion. In addition, the year 2030 was selected as the future year of analysis to be consistent with the statewide model as well as to be consistent with the regional long-range transportation plan. Future project-related emission calculations are based upon changes in traffic and emission factor data. The traffic data include traffic volumes,

vehicle-miles-of-travel, roadway operations, and physical roadway improvements. The emission factor data include emission reduction programs, years of analysis, and roadway speeds.

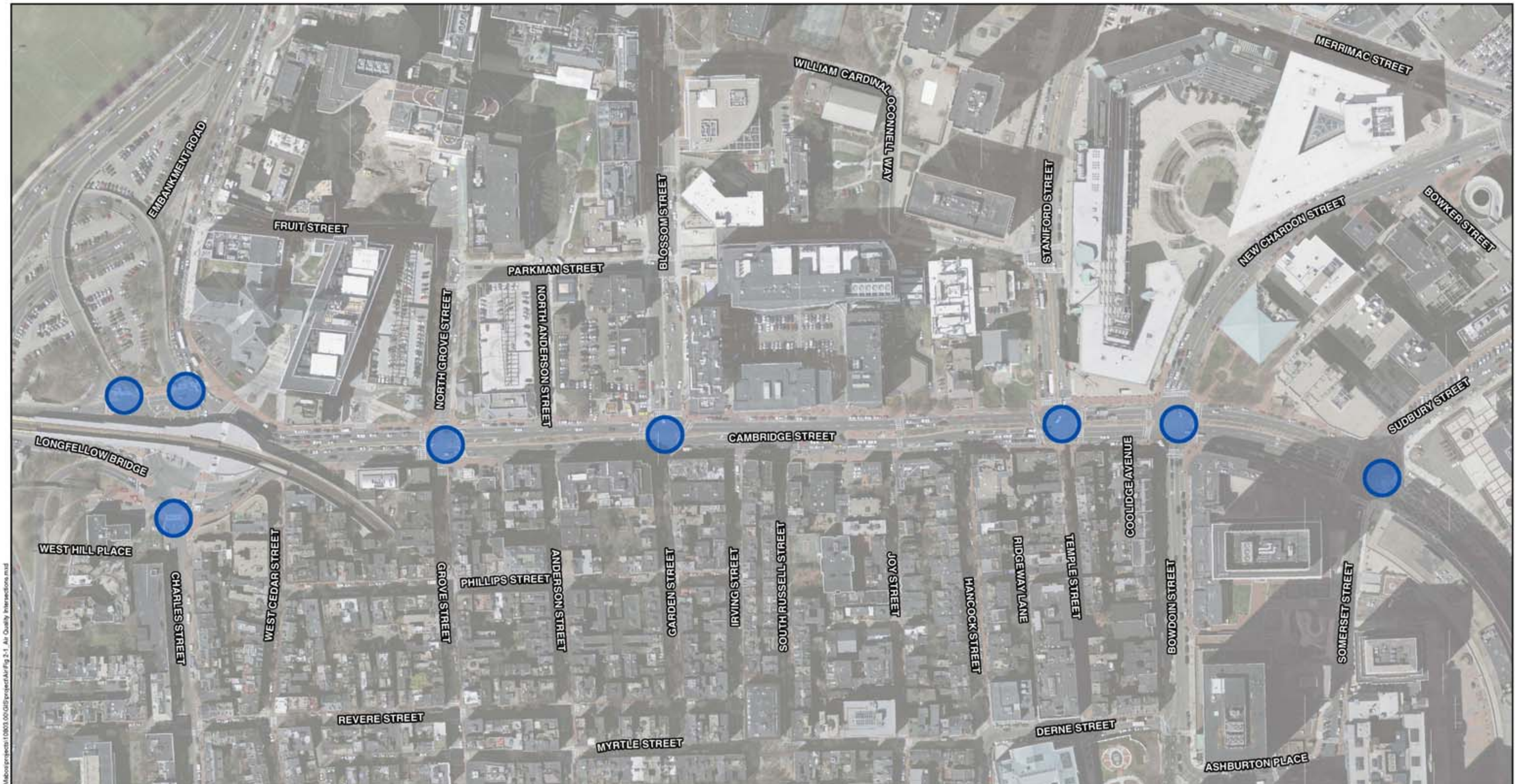
The microscale and mesoscale analyses developed traffic (volumes and speeds) and emission factor data for the 2018 and 2030 No-Build and Build Alternatives. These data were incorporated into air quality models to demonstrate that the proposed Red Line/Blue Line Connector Project would meet the CAAA and SIP criteria. The mesoscale analysis evaluated the regional air quality impacts (VOCs, NO_x, CO_2, CO, and PM emissions) from the proposed project by determining the change in total ozone precursor emissions (volatile organic compounds and nitrogen oxides) for the existing and future conditions within the study area. The microscale analysis calculated the CO and PM concentrations for the same conditions at congested intersections within the study area.

2.1.1 Microscale Analysis Methodology

The microscale analysis evaluated the CO and PM concentrations at congested intersections in the study area. The intersections selected for microscale air quality modeling were selected based upon the procedures outlined by the EPA and as referenced in the Department of Environmental Protection (DEP) guidelines.[2] These procedures require that the intersection be ranked by their levels of service (LOS) and their total traffic volumes and that the air quality analysis model the highest three intersection in each ranking. Intersections in the study area were ranked based on traffic volumes and LOS. As shown in Figure 2-1, the following intersections were selected for analysis because they were the most congested intersections in the study area:

- Cambridge Street at Longfellow Bridge outbound/Storrow Drive Westbound Off-Ramp (Charles Circle)
- Cambridge Street at Charles Street/Storrow Drive Westbound On-Ramp/Charles Street Northbound (Charles Circle)
- Cambridge Street at Charles Street/Storrow Drive Eastbound Off-Ramp/Longfellow Bridge inbound (Charles Circle)
- Cambridge Street at North Grove Street/Grove Street
- Cambridge Street at Blossom Street/Garden Street
- Cambridge Street at Staniford Street/Temple Street
- Cambridge Street at New Chardon Street/Bowdoin Street
- Cambridge Street at New Sudbury Street/Somerset Street

2 *Guidelines for Modeling Carbon Monoxide from Roadway Intersection*, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Technical Support Division; Research Triangle Park, NC; EPA-454/R-92-005; November 1992.



Legend

Study Intersections

0 50 100 200 Feet

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Figure 2-1
Air Quality
Microscale Study Intersections

Red Line/Blue Line Connector
Boston, Massachusetts

Sources: MassGIS & BWSC

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The microscale analysis calculated maximum 1-hour and 8-hour CO concentrations and the 24-hour PM concentrations in the Project area. The EPA's computer model CAL3QHC[3] was used to predict CO and PM concentrations at receptor locations for each intersection. These receptor locations were selected since they are located where the public has access and is expected to be for periods of time. Receptors were placed at the edge of the roadway, but not closer than 10 feet (3 meters) from the nearest travel lane, so that they were not within the roadway mixing cell. The results calculated at these receptor locations represent the highest concentrations at each intersection. Receptor locations farther away from the intersections will have lower concentrations because of the CO and PM dispersion characteristics. The receptor locations that are along the major roadways in the study area are also expected to have lower CO and PM concentrations than intersection receptors. The emission rates for vehicles traveling along these roadways are lower than the emission rates for vehicles queuing at intersections.

2.1.1.1 Background Concentrations

The 1-hour pollutant concentrations were calculated directly using the EPA computer model, with evening peak hour traffic and emission data.

CO Background and Persistence Factors. The 1-hour CO concentrations were calculated directly using the EPA computer model, with evening peak hour traffic and emission data. The 8-hour CO concentrations were derived by applying a persistence factor of 0.68 to the 1-hour CO concentrations. This persistence factor was calculated from the DEP's most recent annual monitoring report.[4] It represents the average ratio of second highest 8-hour to second highest 1-hour CO readings at DEP's Boston-area (Kenmore Square) permanent monitoring station.

The concentrations are expressed in parts per million (ppm) and include a 1-hour and 8-hour background concentration of 3.0 ppm and 2.1 ppm respectively. The CO background concentrations are based on EPA's suggested factors. The 1-hour and 8-hour NAAQS for CO is 35 ppm and 9.0 ppm respectively. The emissions presented represent the highest emissions experienced at each intersection for each alternative. The air quality study assumes that if these intersections meet the NAAQS, then all other intersections, regardless of alternative, which will have lower volumes and better levels of service, can be assumed to also meet the NAAQS. The remaining intersections are included in the Appendix.

PM_{10} Background and Persistence Factors. The microscale analysis calculated the 24-hour PM_{10} concentrations for the No-Build and Build Alternatives. The 1-Hour PM_{10} concentrations were calculated directly using the EPA's CAL3QHC model, with evening peak hour traffic and emission data. The 24-hour PM_{10}

3 *User's Guide to CAL3QHC Version 2.0: A Modeling Methodology for Predicting Pollutant Concentrations Near Roadway Intersections*, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Technical Support Division; Research Triangle Park, NC; EPA-454/R-92-006; November 1992.

4 *2000 Annual Report on Air Quality in New England*, US Environmental Protection Agency, Region I, Lexington, Massachusetts; July 2001.

concentrations were calculated by applying the EPA persistence factor of 0.40 to the 1-hour concentrations. The concentrations are expressed in micrograms per cubic meter (ug/m^3) and include a 24-hour background concentration of 39.3 ug/m^3, which was based on DEP air quality monitoring data. The background concentrations are conservative because they were calculated from the DEP's most recent annual monitoring report[5] at DEP's Boston area (Kenmore Square) permanent monitoring station. The 24-hour NAAQS for PM_{10} is 150.0 ug/m^3.

$PM_{2.5}$ Background and Persistence Factors. The microscale analysis calculated the 24-hour and annual $PM_{2.5}$ concentrations for the No-Build Alternative, the Baseline Alternative, and the Build Alternatives. The 1-Hour $PM_{2.5}$ concentrations were calculated directly using the EPA's CAL3QHC model, with evening peak hour traffic and emission data. The 24-hour $PM_{2.5}$ concentrations were calculated by applying the EPA persistence factor of 0.40 to the 1-hour concentrations and 0.08 for the annual $PM_{2.5}$. The concentrations are expressed in micrograms per cubic meter (ug/m^3) and include a 24-hour background concentration of 28.7 ug/m^3, and an annual background concentration of 11.2 ug/m^{3}which was based on DEP air quality monitoring data. The background concentrations were also calculated from the DEP's most recent annual monitoring report[6] at DEP's Boston-area (Kenmore Square) permanent monitoring station. The 24-hour NAAQS for $PM_{2.5}$ is 35.0 ug/m^3 and 15.0 ug/m^3 for the annual standard.

The highest CO, $PM_{2.5}$ and PM_{10} concentration and its receptor location presented in Chapter 3 represent the highest concentrations for each intersection. Receptor locations located farther away from the intersection have lower concentrations because of the pollutant's dispersion characteristics. Receptor locations that are along major roadways are also expected to have lower pollutant concentrations, because the emission factors for vehicles traveling along these roadways are much lower than the emission rates for vehicles queuing at the modeled intersections. The receptor locations for each intersection are presented in the Appendix.

2.1.1.2 Emission Factors

The vehicle emission factors used in the microscale and mesoscale analysis were obtained using the EPA's MOBILE6.2[7] emissions model. MOBILE6.2 calculates emission factors from motor vehicles in grams per vehicle-mile for existing and future conditions. The emission rates calculated in this air quality study are adjusted to reflect Massachusetts-specific conditions such as the vehicle age distribution, the statewide Inspection and Maintenance (I/M) Program, and the Stage II Vapor Recovery System.[8] VOC and NO_x emission factors for the mesoscale analysis were determined using the DEP recommended temperatures for the summer (ozone)

5 *2000 Annual Report on Air Quality in New England*, US Environmental Protection Agency, Region I, Lexington, Massachusetts; July 2001.

6 *2000 Annual Report on Air Quality in New England*, US Environmental Protection Agency, Region I, Lexington, Massachusetts; July 2001.

7 MOBILE6.2 (Mobile Source Emission Factor Model), September 2003 release from US EPA, Office of Mobile Sources, Ann Arbor, MI.

8 The Stage II Vapor Recovery System is the process of collecting gasoline vapors from vehicles as they are refueled. This requires the use of a special gasoline nozzle at the fuel pump.

season and similarly for the microscale analysis, the CO emission factors were determined using winter (CO) seasons. The MOBILE6.2 input data are presented in the Appendix.

The air quality study used traffic data (volumes, delays, and speeds) developed for each analysis condition. The microscale analysis used the evening peak hour traffic conditions during the CO season (winter).

2.1.2 Mesoscale Analysis Methodology

The predominant sources of regional pollution impacts anticipated from the proposed Red Line/Blue Line Connector Project are emissions reductions resulting from modal travel shifts from private automobiles to rail service. The mesoscale analysis uses traffic and emissions data for existing and future (No-Build and Build) conditions. The general modeling process to determine whether the Red Line/Blue Line Connector Project will have air quality impacts utilized link-by-link travel data from the CTPS statewide traffic model and emission factors derived using the EPA's MOBILE6.2 emission factor model. The link-by-link traffic data includes daily vehicle volumes as well as free flow and congested speeds over each link. The vehicle volumes are combined with the link lengths in order to determine the daily vehicle miles traveled (VMT) over the link. The VMT is then multiplied by the appropriate speed-specific emission factors in order to arrive at the total daily emissions for each link.

The roadways included in the mesoscale study area include the roadways coded in the CTPS statewide model and generally includes Eastern Massachusetts. The mesoscale analysis estimated the future regional VOCs, NO_X, CO_2, CO, and PM emissions due to the changes in average daily traffic volume, roadway characteristics, and vehicle emissions. The mesoscale analysis traffic (volumes, delays, and speeds) and emission factor data were developed for the above listed conditions.

The objective of the mesoscale analysis was to estimate the change in area-wide emissions of ozone precursor VOCs, NO_X, CO, and PM emissions during a typical day and CO_2 emissions during the entire year resulting from implementing the proposed Red Line/Blue Line Connector. The daily area-wide emissions are presented in kilograms per day to be consistent with the SIP emission inventories.

The mesoscale analysis for VOC and NO_X emissions used typical daily peak and off-peak traffic volumes for the ozone season (summer). Vehicle speeds are developed based upon traffic volumes, observed traffic flow characteristics, and roadway capacity.

2.2 Greenhouse Gas Analysis

The Massachusetts Executive Office of Energy and Environmental Affairs has established a GHG emissions policy. The policy requires that proponents of projects

undergoing MEPA review quantify greenhouse gas emissions and identify measures to avoid, minimize, and mitigate those emissions. The MEPA office has developed procedures and guidelines for implementing this policy, which were originally released on October 31, 2007, revised February 3, 2008 and effective on February 3, 2009.

The air quality study calculated the GHG emissions from mobile sources related to the proposed Red Line/Blue Line Connector Project. While GHG emissions include several gases, CO_2 was selected for evaluation because it is the most significant component of transportation-related GHG emissions. The year 2018 was selected as the estimated year of completion and 2030 was selected as the future year of analysis to be consistent with the regional long-range transportation plan. The GHG mobile source analysis traffic (volumes, delays, and speeds) and emission factor data were developed for the following conditions:

- 2009 Existing;
- 2018 No-Build Alternative;
- 2018 Build Alternatives (1 & 2)
- 2030 No-Build Alternative;
- 2030 Build Alternatives (1 & 2)

The GHG mobile source analysis was conducted following procedures similar to the ozone mesoscale analysis. The changes in CO_2 emissions from traffic were based on the average daily traffic volumes, roadway lengths and vehicle emissions factors for existing and new trips for weekday and weekend conditions.

2.2.1 Modeling

The mesoscale mobile source emissions for all of the major transportation modes in eastern Massachusetts for different years were calculated. The modes consist of on-road vehicles such as autos, trucks, and buses as well as certain off-road sources like water transportation and commuter rail. The methodology being used for this Project is the same one that is used for the Federal Certification Activities conducted by the Metropolitan Boston Planning Organization (Boston Region MPO). This methodology has been used in the Regional Metropolitan Transportation Planning process, Air Quality Conformity Determination, and numerous other highway and transit projects.

Mobile vehicle emissions will be modeled using EPA's MOBILE6.2 emission factor model and CTPS's regional travel demand model. This will be conducted for existing conditions and future No-Build and the Build alternatives.

The EPA's MOBILE6.2 emissions model for autos and trucks includes:

- Description of the calculation for auto and truck (motor vehicles) emissions as a function of the MOBILE6.2 emission rates and the Regional Travel Demand Models (RTDM) estimate of vehicle miles of travel (VMT) and congested speed.

- Description of the sources of emissions rates and the method used to calculate pollutant emissions for the public transportation vehicles.

The end product is the estimate of total emissions for a scenario and year. The unit for measuring emission rates for motor vehicles is grams per miles and were calculated using MOBILE6.2, the software developed by EPA. The MPO coordinated with the Massachusetts Department of Environmental Protection (DEP) to develop the inputs to the MOBILE6.2 model for application by the Boston MPO in their air quality modeling. MOBILE6.2 requires a wide range of input parameters, including inspection and maintenance program information and other data such as hot/cold start mix, emission failure rates, vehicle fleet mix, and fleet age distribution. The inputs used for the 2000 Base Year were the same as those used in determining the latest emissions inventory for the Commonwealth of Massachusetts. The inputs used for the years 2009 through 2030 were also received from DEP and include information on programs that were submitted to the EPA as the strategy for the Commonwealth to obtain ambient air quality standards.

MOBILE6.2 produces a lookup table showing grams produced per mile of travel; stratified by roadway type, and speed for each pollutants and season. TABLE 1 of the MOBILE6.2 program contains freeway emission rates for 2030 and TABLE 2 contains emission rates for arterials. 2030 is the horizon year for all forecasting in this study. Emissions rates are provided for the greenhouse gas (CO_2) using MOBILE6.2. It should be noted that the current MOBILE6.2 emission factor model can only generate a CO_2 grams per mile based on fleet average fuel economy for the year modeled and does not vary based on vehicle speed, or roadway type. EPA's next motor vehicle emission model "MOVES -Motor Vehicle Emission Simulator," expected to be released at the end of this year, will allow better greenhouse gas emission assessments in the future.

The calculation of emissions for the greenhouse gas (CO_2) produced by motor vehicles, including park-and-ride and kiss-and-ride trips, are a function of four factors:

- Vehicle Miles Traveled (VMT)
- Congested speeds on the roadways
- Type of roadway (limited access vs. full access)
- Emission factors for the pollutants from MOBILE6.2 by season.

The RTDM includes every major highway, arterial, and collector in the study area. The centroid connectors are a proxy for the local roads. These roadways are represented as links, segments of roadways that have motor vehicles assigned to them in each alternative. Each roadway link and centroid connector has a roadway type and distance associated with it. The highway assignment process calculates how many vehicles are on each link and centroid connector and what its congested speed would be by time of day. The VMT is a function of how many vehicles are on a link and the length of that link. This is done for every link in the model area. The emission factors were held constant in this study for 2030.

The emission factor for CO_2 identified for each link and centroid connector based on its roadway type and congested speed. The emissions produced on each link and centroid connector was simply the product of the emission rate for CO_2 and the VMT. The total emissions were simply the sum of CO_2 for all of the links in the study area by time period. The four time periods are summed to get an emission estimate for an average weekday in 2030.

Observed emission changes are due to mode shifts from auto to transit, resulting in lower VMT and possibly lower congested speeds on the roadway network. Hence, the more auto diversions there are, the more likely the air quality measures will improve from this mode.

2.2.2 Regional Total Greenhouse Gas Emissions

The last step in the GHG analysis is to combine the total emissions estimated for motor vehicle emissions in the model area with that of the emissions estimated for the proposed project to derive a regional total emissions estimate. All of the build scenarios have some motor vehicle reductions and some motor vehicle diversions that change the VMT and congested speeds, which results in lowered emissions.

3

Project Impacts

This Chapter identifies the air quality impacts to neighboring land uses potentially resulting from implementation of the Red Line/Blue Line Connector Project. The results presented in this chapter include the existing conditions, and the future No-Build and Build Alternatives. The microscale (local) impacts along the study corridor are described in Sections 3.1 and the mesoscale (regional) impacts are presented in Section 3.2, including the greenhouse gas assessment.

3.1 Microscale Analysis

Future estimates of Project-related concentrations of CO and PM are based upon changes in traffic and emission factor data. The traffic data include traffic volumes, VMT, signal cycle timing, and physical roadway improvements. The emission factor data include years of analysis and roadway speeds. The microscale analysis for the two Build Alternatives for the proposed Red Line/Blue Line Connector Project is based upon changes in these parameters.

3.1.1 Microscale CO Emissions Results

The microscale analysis calculated CO concentrations for the Existing, No-Build Alternative, and two Build Alternatives. The concentrations are expressed in parts per million (ppm) and include a 1-hour background concentration of 3.0 ppm. The 1-hour CO concentrations were calculated using EPA's *CAL3QHC* model, with evening peak hour traffic and emission data. The 8-hour CO concentrations were derived by applying a persistence factor of 0.70 to the 1-hour CO concentrations. This persistence factor represents the average ratio of second highest 8-hour to second highest 1-hour CO reading. Similar to the 8-hour CO emissions, the concentrations are expressed in parts per million (ppm) and include an 8-hour background concentration of 2.1 ppm.

As presented earlier, the EPA has set the NAAQS for CO to protect the public health. The NAAQS for CO sets maximum concentrations of 35 ppm for a 1-hour period and 9 ppm for an 8-hour period, each not to be exceeded more than once per year.

The microscale results for all the intersections are presented in Table 3-1 and 3-2. All the 1-hour and 8-hour concentrations are below the CO NAAQS of 35 and 9 ppm, respectively. These values are consistent with the area's designation as a CO attainment area. The 2009 existing conditions results of the microscale analysis for the 1-hour CO concentrations ranged from 4.8 ppm to 7.4 ppm which is well below the 1-hour CO NAAQS of 35 ppm. The corresponding 8-hour CO concentrations for 2009 ranged from a minimum of 3.3 ppm to a maximum of 5.2 ppm, which is well below the 8-hour CO NAAQS of 9.0 ppm.

The microscale analysis indicates that reductions in CO concentrations are expected to occur over time when compared to the 2009 existing condition. All of the calculated future CO concentrations (both 1- and 8-hour) are equal to or less than the 2009 existing conditions concentrations. These reductions can be attributed to more efficient vehicles with enhanced emissions control technologies and the benefits of the Massachusetts' vehicle inspection and maintenance program. None of the Existing or future No-Build and Build Alternatives concentrations approaches the CO NAAQS for 1-hour or 8-hour.

The 2018 and 2030 No-Build Alternative 1-hour CO emissions range from a minimum of 4.1 ppm and 4.0 ppm to a maximum of 5.9 ppm and 5.7 ppm respectively. The highest 1-hour Build CO emissions under the Project's 2018 and 2030 Build Alternatives occurred at the Charles Circle (5.9 and 5.7 ppm, respectively). The lowest 2018 and 2030 Build CO emissions of 4.0 ppm and 3.9 ppm would be experienced at the intersection of Cambridge Street at New Sudbury Street/Somerset Street. All of these concentrations are well below the 1-hour CO NAAQS of 35.0 ppm.

Similarly, the No-Build 8-hour CO emissions range from a minimum of 2.9 ppm for 2018 and 2.8 ppm for 2030 to a maximum of 4.1 ppm in 2018 and 4.0 ppm in 2030. The highest 8-hour Build CO emissions under the Project's 2018 and 2030 Build Alternatives occurred at the Charles Circle (4.1 and 4.0 ppm, respectively). The lowest 2018 and 2030 Build 8-hour CO emissions of 2.8 ppm and 2.7 ppm would be experienced at the intersection of Cambridge Street at New Sudbury Street/Somerset Street. All of these concentrations are well below the 8-hour CO NAAQS of 9.0 ppm.

The microscale analysis calculated CO concentrations for the Existing, No-Build Alternative, and two Build Alternatives. The results indicate the both Build alternatives, in both analysis years, are the same as or slightly less than (0.1ppm) the No-Build Alternative.

Table 3-1 Predicted Maximum 1-Hour CO Concentrations (Parts Per Million)[1, 2]

Intersection	2009 Existing	2018 No-Build	2018 Build Alternative 1	2018 Build Alternative 2	2030 No-Build	2030 Build Alternative 1	2030 Build Alternative 2
Charles Circle[3]	7.4	5.9	5.9	5.9	5.7	5.7	5.7
Cambridge Street at North Grove Street/Grove Street	6.7	5.2	5.2	5.2	5.0	4.9	4.9
Cambridge Street at Blossom Street/Garden Street	4.8	4.3	4.2	4.2	4.2	4.1	4.1
Cambridge Street at Staniford Street/Temple Street	5.2	4.4	4.4	4.4	4.3	4.3	4.3.
Cambridge Street at New Chardon Street/Bowdoin Street	5.2	4.4	4.4	4.4	4.3	4.3	4.3
Cambridge Street at New Sudbury Street/Somerset Street	4.8	4.1	4.0	4.0	4.0	3.9	3.9

Source: Vanasse Hangen Brustlin, Inc.

1 The concentrations are expressed in parts per million (ppm) and include a 1-hour background concentration of 3.0 ppm. The 1-hour NAAQS for CO is 35 ppm. The emissions presented represent the highest emissions experienced at each intersection for each alternative. The air quality study assumes that if these intersections meet the NAAQS, then all other intersections, regardless of alternative, which will have lower volumes and better levels of service, can be assumed to also meet the NAAQS.

2 The Build Alternatives used for the air quality analysis include the physical and operational mitigation proposed to improve traffic operations (as outlined in the traffic section).The results are the same for Alternatives 1 and 2 due to the minimal projected traffic changes between the two alternatives (see the *Traffic Technical Report* for more details).

3 Charles Circle includes the intersections of Cambridge Street at Longfellow Bridge Outbound/Storrow Drive Westbound Off-Ramp, Cambridge Street at Charles Street/Storrow Drive Westbound On-Ramp/ Charles Street Northbound and Cambridge Street at Charles Street/Storrow Drive Eastbound Off-Ramp/ Longfellow Bridge inbound. The concentration presented herein represents the highest concentration found at these three intersections.

Table 3-2 Predicted Maximum 8-Hour CO Concentrations (Parts Per Million)[1, 2]

Intersection	2009 Existing	2018 No-Build	2018 Build Alternative 1	2018 Build Alternative 2	2030 No-Build	2030 Build Alternative 1	2030 Build Alternative 2
Charles Circle[3]	5.2	4.1	4.1	4.1	4.0	4.0	4.0
Cambridge Street at North Grove Street/Grove Street	4.7	3.6	3.6	3.6	3.5	3.4	3.4
Cambridge Street at Blossom Street/Garden Street	3.4	3.0	2.9	2.9	2.9	2.9	2.9
Cambridge Street at Staniford Street/Temple Street	3.6	3.1	3.1	3.1	3.0	3.0	3.0
Cambridge Street at New Chardon Street/Bowdoin Street	3.6	3.1	3.1	3.1	3.0	3.0	3.0
Cambridge Street at New Sudbury Street/Somerset Street	3.3	2.9	2.8	2.8	2.8	2.7	2.7

Source: Vanasse Hangen Brustlin, Inc.

1 The concentrations are expressed in parts per million (ppm) and include an 8-hour background concentration of 3.0 ppm and a persistence factor of 0.70. The 8-hour NAAQS for CO is 9 ppm. The emissions presented represent the highest emissions experienced at each intersection for each alternative. The air quality study assumes that if this intersection meets the NAAQS, then all other intersections, regardless of alternative, which will have lower volumes and better levels of service, can be assumed to also meet the NAAQS.

2 The Build Alternatives used for the air quality analysis include the physical and operational mitigation proposed to improve traffic operations (as outlined in the traffic section).The results are the same for Alternatives 1 and 2 due to the minimal projected traffic changes between the two alternatives (see the *Traffic Technical Report* for more details).

3 Charles Circle includes the intersections of Cambridge Street at Longfellow Bridge Outbound/Storrow Drive Westbound Off-Ramp, Cambridge Street at Charles Street/Storrow Drive Westbound On-Ramp/ Charles Street Northbound and Cambridge Street at Charles Street/Storrow Drive Eastbound Off-Ramp/ Longfellow Bridge inbound. The concentration presented herein represents the highest concentration found at these three intersections.

3.1.2 Microscale PM10 Emissions Results

The microscale analysis calculated the 24-hour PM_{10} concentrations for the Existing, No-Build Alternative, and two Build Alternatives. The 24-hour PM_{10} concentrations were calculated using EPA's CAL3QHC model. The concentrations are expressed in micrograms per cubic meter (ug/m^3) and include a 24-hour background

concentration of 39.3 ug/m^3, which was based on MassDEP air quality monitoring data presented in the *New England Annual Air Quality Report*.[9]

Table 3-3 presents the 24-hour PM_{10} concentrations for the Project. The 2018 and 2030 24-hour PM_{10} concentrations for the Build Alternatives ranged from a minimum of 40.5 ug/m^3 to a maximum of 42.9 ug/m^3. All of the 24-hour PM_{10} concentrations are well below the PM NAAQS of 150 ug/m^3.

The microscale analysis calculated PM_{10} concentrations for the Existing, No-Build Alternative, and two Build Alternatives. The results indicate the both Build alternatives, in both analysis years, are the same as or slightly less than (0.1 ug/m^3) the No-Build Alternative. There is virtually no difference between the two Build Alternatives (1 and 2).

3.1.3 Microscale PM2.5 Emissions Results

The microscale analysis calculated the 24-hour and annual $PM_{2.5}$ concentrations for the Existing, No-Build Alternative, and the two Build Alternatives. The 1-hour $PM_{2.5}$ concentrations were calculated using EPA's CAL3QHC model and were then adjusted using MassDEP standards to develop the 24-hour and annual $PM_{2.5}$ concentrations (as discussed in Section 2.1.1. *Background Concentrations*). The concentrations are expressed in micrograms per cubic meter (ug/m^3) and include an annual background concentration of 11.2 ug/m^3 a 24-hour background concentration of 28.7 ug/m^3 and which was based on DEP air quality monitoring data. Tables 3-4 and 3-5 present the results of the microscale analysis for the annual and 24-hour $PM_{2.5}$, respectively.

The 2018 Build annual $PM_{2.5}$ concentrations for the Build Alternatives ranged from a minimum of 11.4 ug/m^3 to a maximum of 11.5 ug/m^3. The 2030 Build annual $PM_{2.5}$ concentrations for the Build Alternatives ranged from a minimum of 11.3 ug/m^3 to a maximum of 11.5 ug/m^3. All of the annual $PM_{2.5}$ concentrations are well below the $PM_{2.5}$ NAAQS of 15 ug/m^3.

The 2018 Build 24-hour $PM_{2.5}$ concentrations for the Build Alternatives ranged from a minimum of 29.5 ug/m^3 to a maximum of 30.3 ug/m^3. The 2030 Build 24-hour $PM_{2.5}$ concentrations for the Build Alternatives ranged from a minimum of 29.1 ug/m^3 to a maximum of 30.3 ug/m^3. All of the 24-hour $PM_{2.5}$ concentrations are below the $PM_{2.5}$ NAAQS of 35 ug/m^3.

The microscale analysis calculated $PM_{2.5}$ concentrations for the Existing, No-Build Alternative, and two Build Alternatives. The results indicate the 24-hour and annual $PM_{2.5}$ emissions for both Build alternatives, in both analysis years, are the same as or

9 *2006 New England Annual Report on Air Quality*, United States Environmental Protection Agency, Region 1, Office of Environmental Measurement and Evaluation North Chelmsford, MA 01863, Ecosystems Assessment Unit, July 2007. (http://www.epa.gov/region01/lab/reportsdocuments.html).

slightly less than (0.1 ug/m³) the No-Build Alternative. There is virtually no difference between the two Build Alternatives (1 and 2).

Table 3-3 Predicted Maximum 24-Hour PM_{10} Concentrations (Micrograms per Cubic Meter (ug/m))[1, 2]

Intersection	2009 Existing	2018 No-Build	2018 Build Alternative 1	2018 Build Alternative 2	2030 No-Build	2030 Build Alternative 1	2030 Build Alternative 2
Charles Circle[3]	44.5	42.9	42.9	42.9	42.9	42.9	42.9
Cambridge Street at North Grove Street/Grove Street	42.5	41.7	41.7	41.7	41.7	41.3	41.3
Cambridge Street at Blossom Street/Garden Street	41.3	40.9	40.9	40.9	40.9	40.9	40.9
Cambridge Street at Staniford Street/Temple Street	41.3	40.9	40.9	40.9	40.9	40.5	40.5
Cambridge Street at New Chardon Street/Bowdoin Street	41.7	40.9	40.9	40.9	40.9	40.5	40.5
Cambridge Street at New Sudbury Street/Somerset Street	41.3	40.9	40.5	40.5	40.5	40.5	40.5

Source: Vanasse Hangen Brustlin, Inc.

1 The concentrations are expressed in micrograms per cubic meter (ug/m³) and include a 24-hour background concentration of 39.3 ug/m3 and a persistence factor of 0.40.. The NAAQS for PM_{10} is 150 ug/m3. The emissions presented represent the highest emissions experienced at each intersection for each alternative. The air quality study assumes that if this intersection meets the NAAQS, then all other intersections, regardless of alternative, which will have lower volumes and better levels of service, can be assumed to also meet the NAAQS.

2 The Build Alternatives used for the air quality analysis include the physical and operational mitigation proposed to improve traffic operations (as outlined in the traffic section).The results are the same for Alternatives 1 and 2 due to the minimal projected traffic changes between the two alternatives (see the *Traffic Technical Report* for more details).

3 Charles Circle includes the intersections of Cambridge Street at Longfellow Bridge Outbound/Storrow Drive Westbound Off-Ramp, Cambridge Street at Charles Street/Storrow Drive Westbound On-Ramp/ Charles Street Northbound and Cambridge Street at Charles Street/Storrow Drive Eastbound Off-Ramp/ Longfellow Bridge inbound. The concentration presented herein represents the highest concentration found at these three intersections.

Table 3-4 Predicted Maximum Annual $PM_{2.5}$ Concentrations (Micrograms per Cubic Meter (ug/m))[1, 2]

Intersection	2009 Existing	2018 No-Build	2018 Build Alternative 1	2018 Build Alternative 2	2030 No-Build	2030 Build Alternative 1	2030 Build Alternative 2
Charles Circle	11.8	11.5	11.5	11.5	11.5	11.5	11.5
Cambridge Street at North Grove Street/Grove Street	11.6	11.4	11.4	11.4	11.4	11.4	11.4
Cambridge Street at Blossom Street/Garden Street	11.4	11.4	11.4	11.4	11.4	11.4	11.4
Cambridge Street at Staniford Street/Temple Street	11.4	11.4	11.4	11.4	11.4	11.4	11.4
Cambridge Street at New Chardon Street/Bowdoin Street	11.4	11.4	11.4	11.4	11.4	11.4	11.4
Cambridge Street at New Sudbury Street/Somerset Street	11.4	11.4	11.4	11.4	11.4	11.3	11.3

Source: Vanasse Hangen Brustlin, Inc.

1 The concentrations are expressed in micrograms per cubic meter (ug/m^3) and include an annual background concentration of 11.2 ug/m3 and a persistence factor of 0.08. The NAAQS for annual $PM_{2.5}$ is 15 ug/m3. The emissions presented represent the highest emissions experienced at each intersection for each alternative. The air quality study assumes that if this intersection meets the NAAQS, then all other intersections, regardless of alternative, which will have lower volumes and better levels of service, can be assumed to also meet the NAAQS.

2 The Build Alternatives used for the air quality analysis include the physical and operational mitigation proposed to improve traffic operations (as outlined in the traffic section).The results are the same for Alternatives 1 and 2 due to the minimal projected traffic changes between the two alternatives (see the *Traffic Technical Report* for more details).

3 Charles Circle includes the intersections of Cambridge Street at Longfellow Bridge Outbound/Storrow Drive Westbound Off-Ramp, Cambridge Street at Charles Street/Storrow Drive Westbound On-Ramp/ Charles Street Northbound and Cambridge Street at Charles Street/Storrow Drive Eastbound Off-Ramp/ Longfellow Bridge inbound. The concentration presented herein represents the highest concentration found at these three intersections.

Table 3-5 Predicted Maximum 24-Hour $PM_{2.5}$ Concentrations (Micrograms per Cubic Meter (ug/m))[1, 2]

Intersection	2009 Existing	2018 No-Build	2018 Build Alternative 1	2018 Build Alternative 2	2030 No-Build	2030 Build Alternative 1	2030 Build Alternative 2
Charles Circle	31.9	30.3	30.3	30.3	30.3	30.3	30.3
Cambridge Street at North Grove Street/Grove Street	30.7	29.5	29.5	29.5	29.5	29.5	29.5
Cambridge Street at Blossom Street/ Garden Street	29.9	29.5	29.5	29.5	29.5	29.5	29.5
Cambridge Street at Staniford Street/Temple Street	29.9	29.5	29.5	29.5	29.5	29.5	29.5
Cambridge Street at New Chardon Street/Bowdoin Street	29.9	29.5	29.5	29.5	29.5	29.5	29.5
Cambridge Street at New Sudbury Street/Somerset Street	29.9	29.5	29.5	29.5	29.5	29.1	29.1

Source: Vanasse Hangen Brustlin, Inc.

1 The concentrations are expressed in micrograms per cubic meter (ug/m^3) and include a 24-hour background concentration of 28.7 ug/m3 and a persistence factor of 0.40. The NAAQS for 24-hour $PM_{2.5}$ is 35.0 ug/m3. The emissions presented represent the highest emissions experienced at each intersection for each alternative. The air quality study assumes that if this intersection meets the NAAQS, then all other intersections, regardless of alternative, which will have lower volumes and better levels of service, can be assumed to also meet the NAAQS.

2 The Build Alternatives used for the air quality analysis include the physical and operational mitigation proposed to improve traffic operations (as outlined in the traffic section).The results are the same for Alternatives 1 and 2 due to the minimal projected traffic changes between the two alternatives (see the *Traffic Technical Report* for more details).

3 Charles Circle includes the intersections of Cambridge Street at Longfellow Bridge Outbound/Storrow Drive Westbound Off-Ramp, Cambridge Street at Charles Street/Storrow Drive Westbound On-Ramp/ Charles Street Northbound and Cambridge Street at Charles Street/Storrow Drive Eastbound Off-Ramp/ Longfellow Bridge inbound. The concentration presented herein represents the highest concentration found at these three intersections.

3.2 Mesoscale Analysis

The air quality study included a mesoscale analysis that estimates the area wide emissions of VOCs, NO_X, CO_2, CO, and PM emissions. The mesoscale analysis evaluated the changes in emissions based upon changes in the average daily traffic volumes, roadway lengths, and vehicle emission rates. To demonstrate compliance with the SIP criteria, the air quality study must show the proposed Red Line/Blue Line Connector Project's change in daily (24-hour period) VOC and NO_X emissions. Using EPA-recommended air quality modeling techniques, total pollutant emissions were calculated for the No-Build Alternative and the Build Alternatives. The mesoscale analysis calculated the 2018 and 2030 mobile source emissions from the major roadways in the study area. These emissions establish a baseline to which future emissions can be compared. Table 3-6 presents the mesoscale analysis results.

The No-Build Alternative VOC and NO_X emissions are typically lower than the existing conditions emissions due to the implementation of state and federal emission control programs, such as the Federal Motor Vehicle Emission Control Program, the Stage II Vapor Recovery System, and the Massachusetts Inspection and Maintenance program. Table 3-6 presents the mesoscale analysis results for all the alternatives.

The results of the mesoscale analysis demonstrate that all of the Build Alternatives would reduce emissions of VOC, NO_X, $PM_{2.5}$, PM_{10} and CO (Winter) as compared to the No-Build Alternative. These reductions range from 1.4 to 1.8 kg/day for VOC emissions, 0.8 to 2.7 kg/day in NO_X, emissions, 0.1 kg/day of $PM_{2.5}$ emissions, 0.1 to 0.2 kg/day of PM_{10} emissions and 42.7 to 62.9 kg/day of CO (Winter) emissions. A comparison of VOC, NO_X, $PM_{2.5}$, PM_{10} and CO-Winter emissions for the Existing, 2018 and 2030 No-Build Alternative and the Build Alternatives is presented in Figure 3-1. There is no difference between the two Build Alternatives.

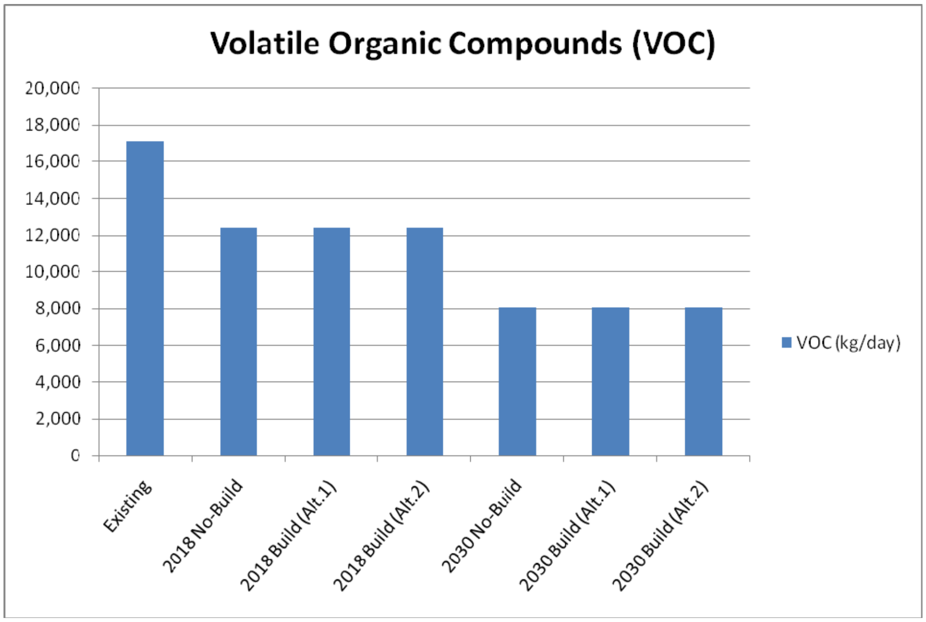
Table 3-6 Mesoscale Mobile Source Analysis Results (kilograms per day)

Pollutant	2009 Existing	2018 No-Build	2018 Build (Alternative 1)	2018 Build (Alternative 2)	2030 No-Build	2030 Build (Alternative 1)	2030 Build (Alternative 2)
Vehicle Miles Traveled (VMT) [1]	34,474,957	35,675,241	35,669,992	35,669,992	37,340,874	37,335,625	37,335,625
Volatile Organic Compounds (VOCs)	17,155.9	12,404.0	12,402.1	12,402.1	8,049.2	8,047.9	8,047.9
Build / No-Build Difference			(1.8)	(1.8)		(1.4)	(1.4)
Nitrogen Oxides (NO_x)	41.183.1	18.534.9	18.532.2	18.532.2	6.392.7	6.391.9	6.391.9
Build / No-Build Difference			(2.7)	(2.7)		(0.8)	(0.8)
Particulate Matter 2.5 ($PM_{2.5}$)	954.1	709.7	709.6	709.6	478.3	478.2	478.2
Build / No-Build Difference			(0.1)	(0.1)		(0.1)	(0.1)
Particulate Matter 10 (PM_{10})	1,509.5	1,280.8	1,280.6	1,280.6	1,028.9	1,028.7	1,028.7
Build / No-Build Difference			(0.2)	(0.2)		(0.1)	(0.1)
Carbon Monoxide (CO-Winter)	515,607.5	427,680.9	427,618.0	427,618.0	333,314.4	333,271.7	333,271.7
Build / No-Build Difference			(62.9)	(62.9)		(42.7)	(42.7)

1 VMT represents the vehicle miles traveled on an average weekday in 2030.

2 The Build Alternatives used for the air quality analysis include the physical and operational mitigation proposed to improve traffic operations (as outlined in the traffic section).

Figure 3-1 Mesoscale Mobile Source Analysis Results (kilograms per day)



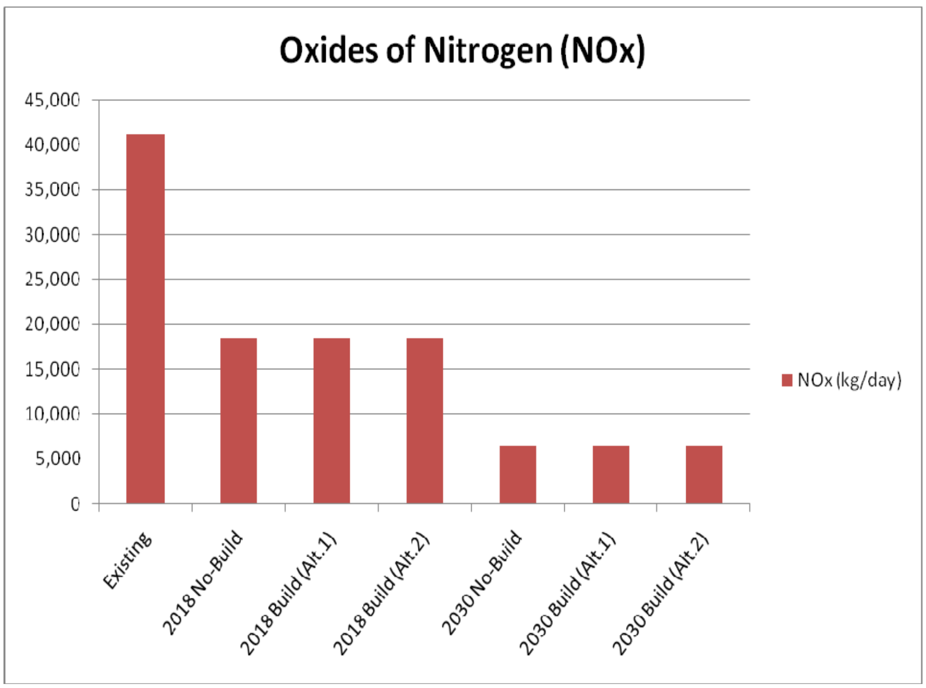
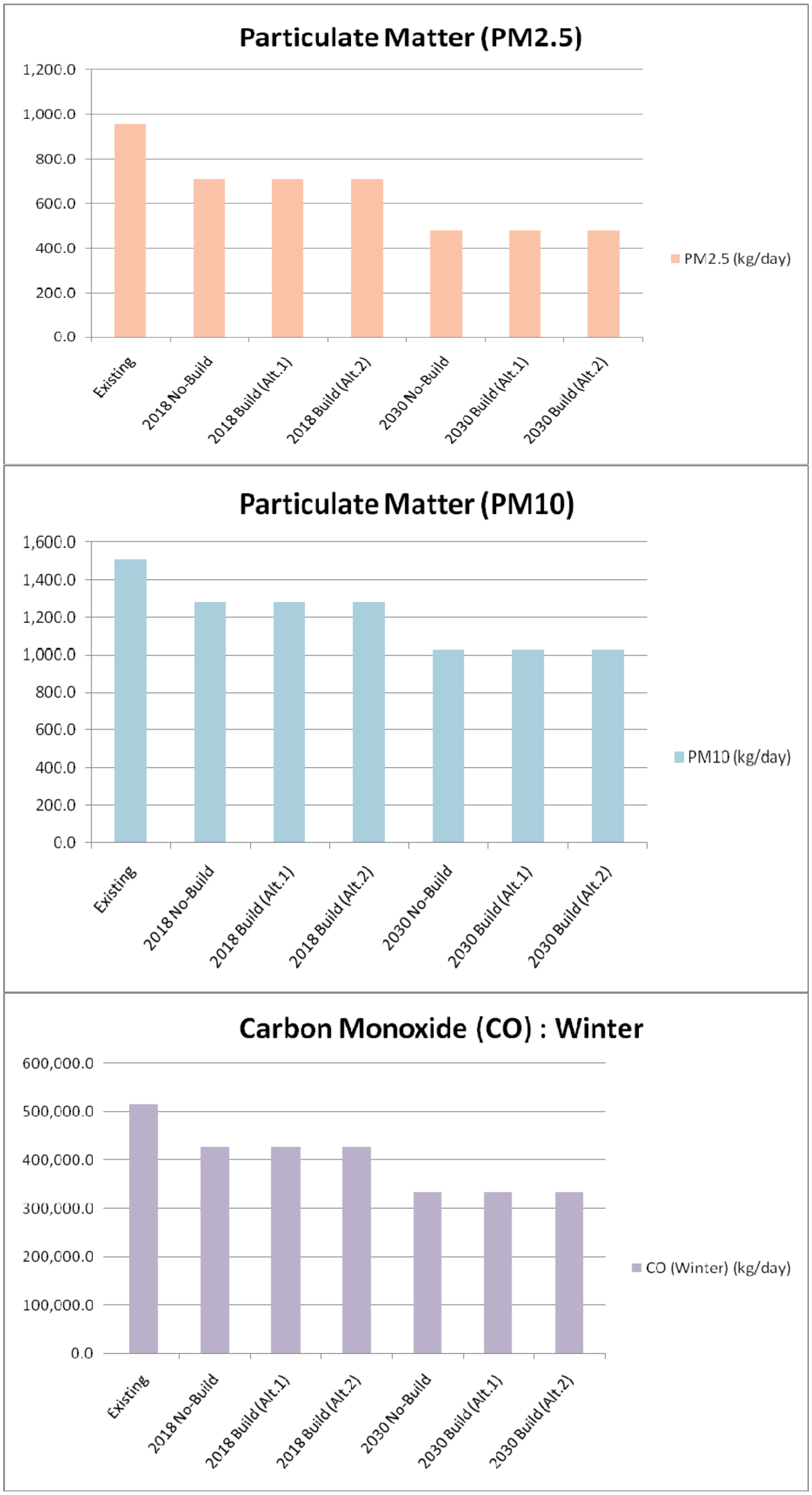


Figure 3-2 Mesoscale Mobile Source Analysis Results (kilograms per day)



As Table 3-6 and Figure 3-2 and 3-3 show, the Build Alternatives result in minor reductions in emissions of VOCs, NO_X, and PM_{10} as compared to the No-Build Alternative. This is consistent with the reduction of approximately 5,000 VMT between the No-Build and Build Alternatives. The air quality study demonstrates that all alternatives for the proposed Red Line/Blue Line Connector Project comply with the CAAA and the SIP. The ozone mesoscale analysis demonstrates that all Build Alternatives will result in a decrease of VOC, NO_X and PM_{10} emissions, as compared to the No-Build Alternative.

3.3 Greenhouse Gas (CO2) Analysis

The Executive Office of Energy and Environmental Affairs (EEA) has developed a policy that requires a project to evaluate GHG emissions. The air quality study calculated the GHG emissions from mobile sources related to the proposed Red Line/Blue Line Connector Project. While GHG emissions include several gases, CO_2 was selected for evaluation because it is the most significant component of transportation-related GHG emissions. The year 2018 was selected as the estimated year of completion and 2030 was selected as the future year of analysis to be consistent with the regional long-range transportation plan.

The GHG mobile source analysis was conducted following procedures similar to the ozone mesoscale analysis. The changes in CO_2 emissions from traffic were based on the average daily traffic volumes, roadway lengths and vehicle emissions factors for existing and new trips for weekday and weekend conditions.

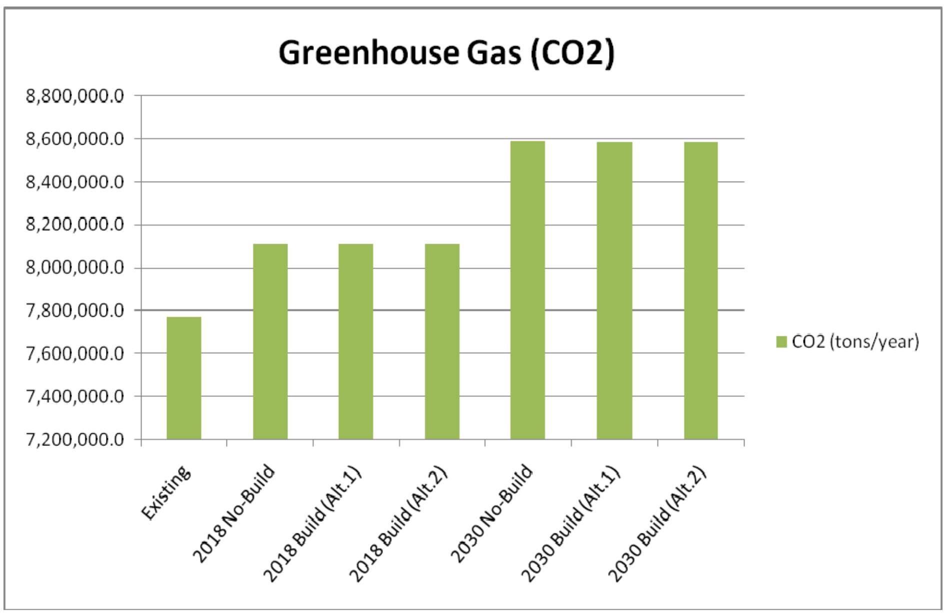
The mesoscale analysis estimated the future study area CO_2 emissions due to the changes in traffic and emission data. Table 3-7 presents a summary of the CO_2 emissions projected under each proposed alternative. Under the 2018 No-Build Alternative, CO_2 emissions were estimated to be 8,111,522 tons/year. Under the 2030 No-Build Alternative the CO_2 emissions were estimated to be 8,587,275 tons/year.

The mesoscale results for the two Build Alternatives (Alternatives 1 and 2) suggest that the difference in air quality emissions between the two alternatives is negligible on a regional basis. Alternatives 1 and 2 would provide CO_2 emission reductions on the order of 1,194 tons/year in the year 2018 and 1,236 tons/year under 2030 conditions.

Table 3-7 Greenhouse Gas (CO_2) Analysis Results

Alternative	CO_2 Emissions in kilograms/day: Carbon Dioxide (CO_2)	CO_2 Emissions in kilograms/day: Change from No-Build	CO_2 Emissions in tons/year: Carbon Dioxide (CO_2)	CO_2 Emissions in tons/year: Change from No-Build
2009 Existing	19,304,224		7,772,085	
2018 No-Build	20,147,313		8,111,522	
2018 Build (Alternative 1)	20,144,349	-2,964	8,110,329	-1,193
2018 Build (Alternative 2)	20,144,349	-2,964	8,110,329	-1,193
2030 No-Build	21,328,985		8,587,275	
2030 Build (Alternative 1)	21,325,913	-2,964	8,586,039	-1,236
2030 Build (Alternative 2)	21,325,913	-2,964	8,586,039	-1,236

Figure 3-3 Greenhouse Gas Mesoscale Mobile Source Analysis Results (kilograms per day)



3.4 Air Toxics

The air quality study evaluated the potential for impact due to air toxics, as required in the Secretary's Certificate. Most air toxics originate from human-made sources, including on-road mobile sources, non-road mobile sources (e.g., airplanes), area sources (e.g., dry cleaners) and stationary sources (e.g., factories or refineries). Controlling air toxic emissions became a national priority with the passage of the CAAA of 1990, whereby Congress mandated that the EPA regulate 188 air toxics, also known as hazardous air pollutants. Mobile Source Air Toxics (MSATs) are a subset of the 188 air toxics defined by the CAAA. The MSATs are compounds emitted from highway vehicles and non-road equipment. Some toxic compounds are present in fuel and are emitted to the air when the fuel evaporates or passes through the engine unburned. Other toxics are emitted from the incomplete combustion of fuels or as secondary combustion products. The Red Line/Blue Line Connector Project is not expected to generate any substantial amount of air toxics in the study area because the train engines are electric and will not result in the combustion of fuels and the project will also reduce VMT.

3.5 Transportation Conformity

The proposed Red Line/Blue Line Connector Project is required by the SIP and fulfills a longstanding commitment of the Central Artery/Tunnel Project to increase public transit. The Massachusetts Air Pollution Control Regulations (310 CMR 7.36: Transit System Improvements) require that EOT complete the final design of the Red Line/Blue Line Connector, from the Blue Line at Government Center to the Redline at Charles Station by December 31, 2011.

The Massachusetts Transit System Improvements regulation (310 CMR 7.36) became effective in December of 1991 and was incorporated into the Massachusetts SIP in October of 1994.[10] This regulation specified transit system improvement projects deemed necessary to mitigate the air quality impacts of the Central Artery and Third Harbor Tunnel Project. While a number of projects included in 310 CMR 7.36 were completed, several transit system improvement projects (Green Line Arborway Restoration, the Blue Line Connection from Bowdoin Station to the Red Line at Charles Station, and the Green Line Extension to Ball Square/Tufts University) were delayed and it was determined would not be completed within the required SIP timeframes. The EOT and DEP established an Administrative Consent Order (ACO) in 2000, which addressed revised schedules for implementation. The ACO was revised in 2002 and 2005 to address additional compliance issues.

310 CMR 7.36, as adopted in 1991, included a substitution process for changing projects that are included in the regulation and the approved SIP. In 2005, EOT initiated the process for the substitution of the original SIP projects with a new

10 Federal Register (59 FR 50495--50498), dated October 4, 1994.

package of projects which included an extension of the Green Line to Medford Hillside with a spur to Union Square, improvements to the Fairmount Line, and the construction of an additional 1,000 Park and Ride spaces. Following a public process on the proposed substitute projects, EOT submitted a request to DEP to revise the 310 CMR 7.36 and the SIP.[11] Air quality modeling was done for these projects in 2006 with results shown here in Table 5.6-10, demonstrating that the package of substitution projects would – as required – achieve a minimum of 110 percent of the emissions reductions that would have been achieved if the original SIP projects had been built relative to a common no-build scenario for the year 2025.

Table 3-7 EOT Air Quality Analysis Comparison of Project Packages Benefits in the Year 2025

	Daily Emissions Benefits in Kilograms (kg)		
	Carbon Monoxide (CO)	Nitrogen Oxides (NOx)	Volatile Organic Compounds (VOC)
SIP Approved Projects (Package): Arborway; Green Line Extension to Ball Square/Tufts; Blue Line/Red Line Connection (Bowdoin Station to Charles Station)	292	8	11
SIP Approved Projects (Package) Plus Ten Percent	321.2	8.8	12.1
Replacement/Substitution Projects (Package): Blue Line/Red Line Connection (Design Only), Green Line Extension to Union Square and Medford Hillside, Fairmont Line Improvements, and Additional Parking	435	11	17

On July 31, 2008, the EPA approved the SIP revision that had been submitted by the Commonwealth of Massachusetts.[12] This revision revises the list of required transit projects, changes the completion dates for the delayed transit projects, provides interim deadlines for projects, maintains requirements for interim emission reduction offsets in the event a project becomes delayed, modifies the project substitution process, and expands public participation in and oversight of the required projects.

The Project meets the Transportation Conformity planning-level conformity requirements because the Red Line/Blue Line Connector Project is part of an approved SIP. The Project meets the Transportation Conformity project-level conformity requirements because it includes an air quality analysis using MOBILE6.2 and CAL3QHC demonstrating that it meets the NAAQS. The air quality analyses conducted and presented in this DEIR indicate that both Build Alternatives are well below the NAAQS. The emissions for both alternatives reviewed for both the mesoscale (VOC, NO_x and PM_{10}) and the microscale (CO and PM_{10}) analyses are

11 DEP adopted revisions to 310 CMR 7.36 on December 1, 2006 and submitted SIP revisions to EPA.
12 Federal Register / Vol. 73, No. 148 / Thursday, July 31, 2008 / Rules and Regulations, Environmental Protection Agency, 40 CFR Part 52 [EPA–R01–OAR–2006–1018; A–1–FRL–8691–5].

below the NAAQS requirements. Overall, the Build Alternatives show a reduction in emissions for each of the assessed pollutants of concern.

The 1990 Clean Air Act Amendments require that states with non-attainment areas evaluate the air quality impacts of transportation and transit projects during the planning process. The Metropolitan Planning Organizations are responsible for the development of the Long Range Transportation Plans (Plans), the State Transportation Improvement Programs (STIPs), and Projects. The STIP is a list of statewide intermodal program of transportation projects funded by the FTA or FHWA, which are consistent with the Statewide Long Range Transportation Plan and the Massachusetts Transportation Improvement Program. For the Regional Transportation Plan and TIP, conformity is determined in relation to the SIP mobile source emission budgets.

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4

Construction Impacts

4.1 Construction Activities

Construction activities associated with utility relocation, grading, excavation, track and tunnel work, and the installation of systems components could result in temporary air quality impacts. Air quality in the study area is not expected to be substantially affected by project construction because of the temporary nature of the construction and the confined construction area. Emissions from the operation of construction machinery could include nitrogen oxides, sulfur oxides, carbon monoxide, and particulate matter.

In an effort to reduce air quality emissions from temporary construction activities, the Project will contractually require the construction contractors to adhere to all applicable regulations regarding control of construction vehicles emissions. This will include, but not be limited to, maintenance of all motor vehicles, machinery, and equipment associated with construction activities and proper fitting of equipment with mufflers or other regulatory-required emissions control devices. Also, the prohibition of excessive idling of construction equipment engines will be implemented, as required by MA DEP regulations in 310 CMR 7.11.

Additionally, construction specifications will require that all diesel construction equipment used on-site will be fitted with after-engine emission controls, such as diesel oxidation catalysts (DOCs) or diesel particulate filters (DPFs)[13]. Additionally, the Project will contractually require the construction contractors to utilize ultra-low sulfur diesel fuel for all off-road construction vehicles as an additional measure to reduce air emissions from construction activities. The Project will put idling restriction signs on the premises to remind drivers and construction personnel of the state's idling regulation.

The contractor will also be responsible for protective measures around the construction and demolition work to protect pedestrians and prevent dust and debris from leaving the site or entering the surrounding community. Dust generated from earthwork and other construction activities like stockpiled soils will be controlled by

13 This is consistent with the Certificate of Construction Equipment Standard Compliance Form required for all bids to the MBTA.

spraying with water to mitigate wind erosion on open soil areas. Other dust suppression methods will be implemented to ensure minimization of the off-site transport of dust. There will be regular sweeping of the pavement of adjacent roadway surfaces during the construction period to minimize the potential for vehicular traffic to create airborne dust and particulate matter.

Appendix A